Title: Information Generating Apparatus, Image Pickup Apparatus and Image Pickup Method
Inventor: Mitsuaki OSHIMA
Docket No. 49288.1800
EL426461938US

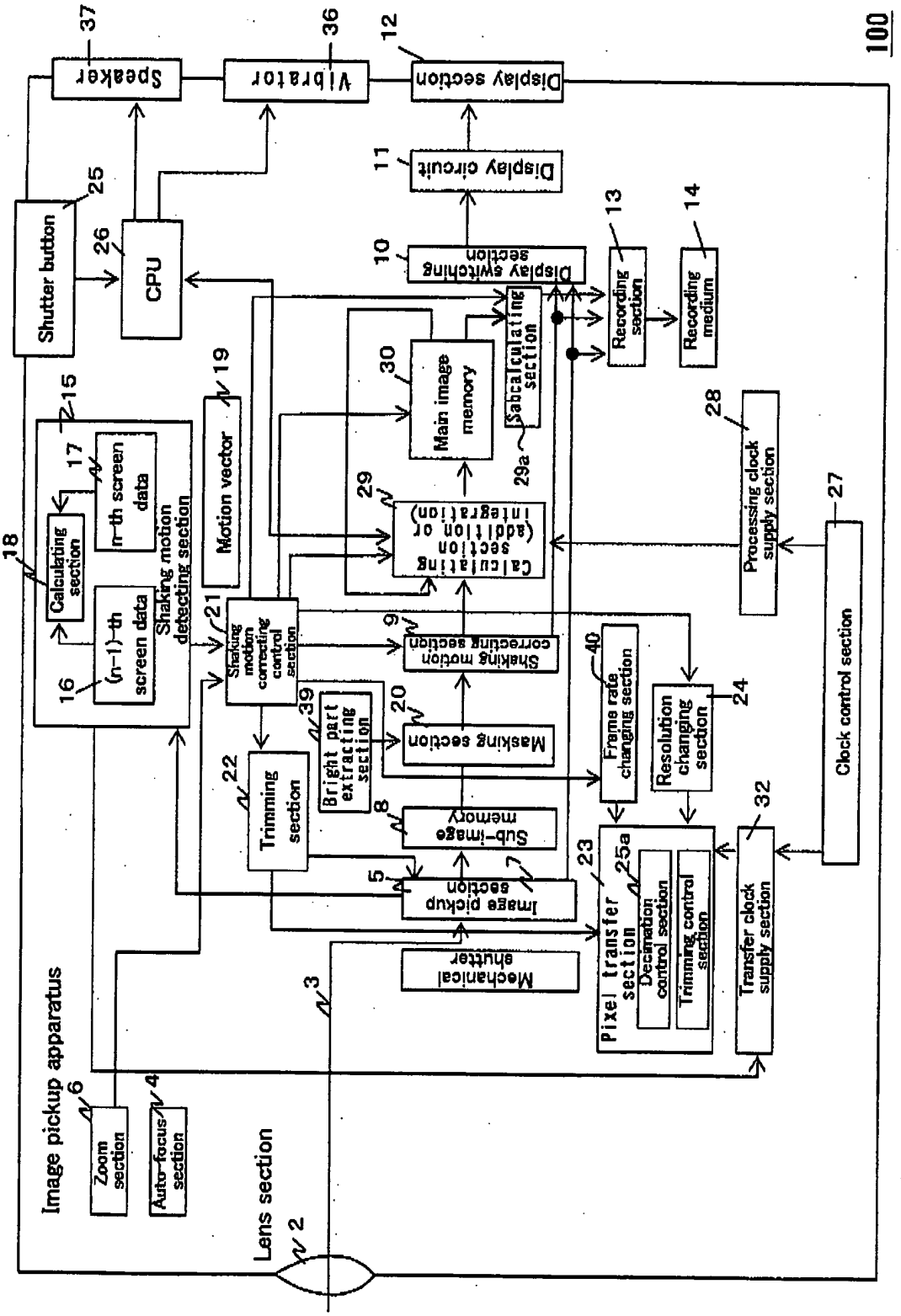


FIG.1

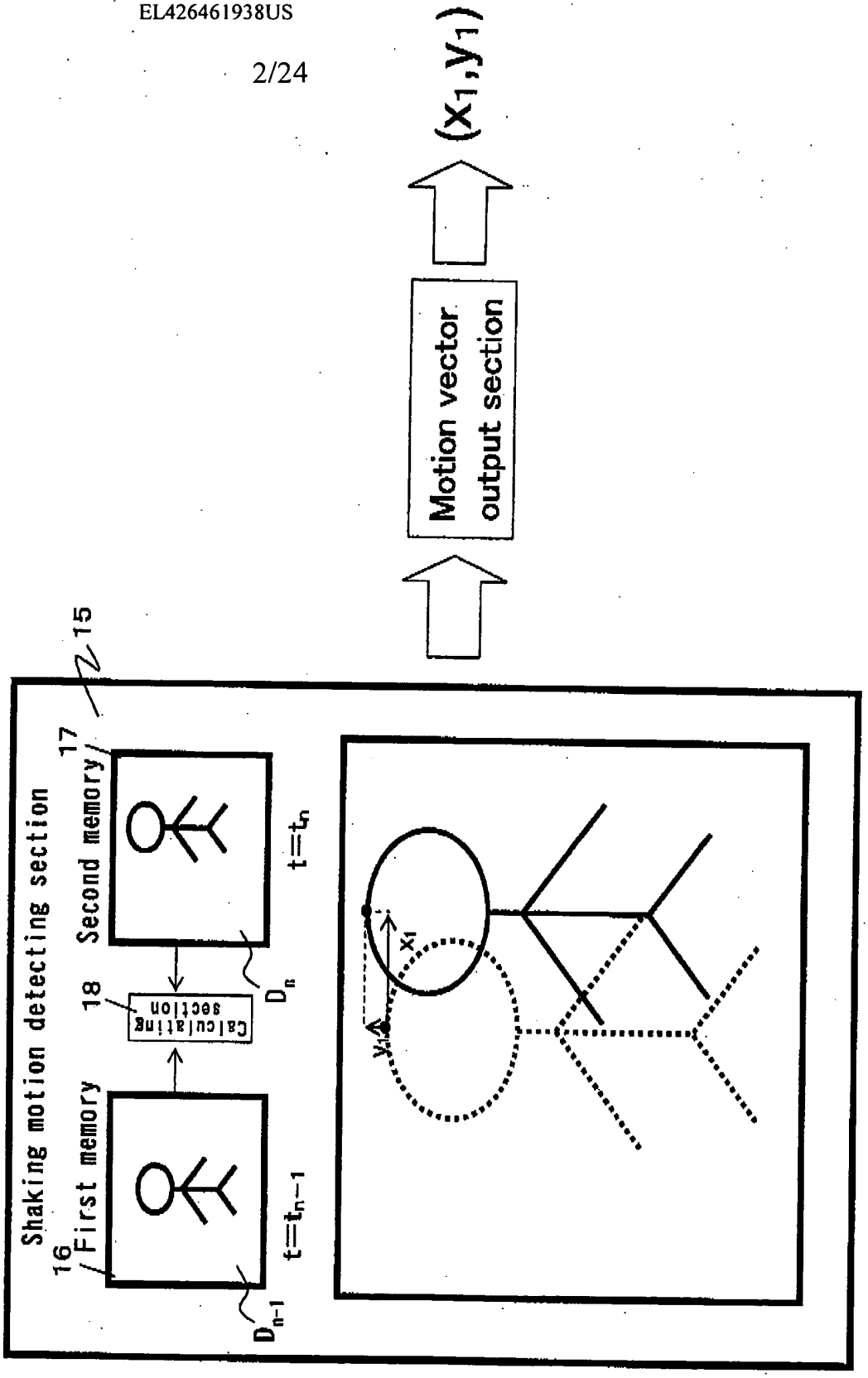
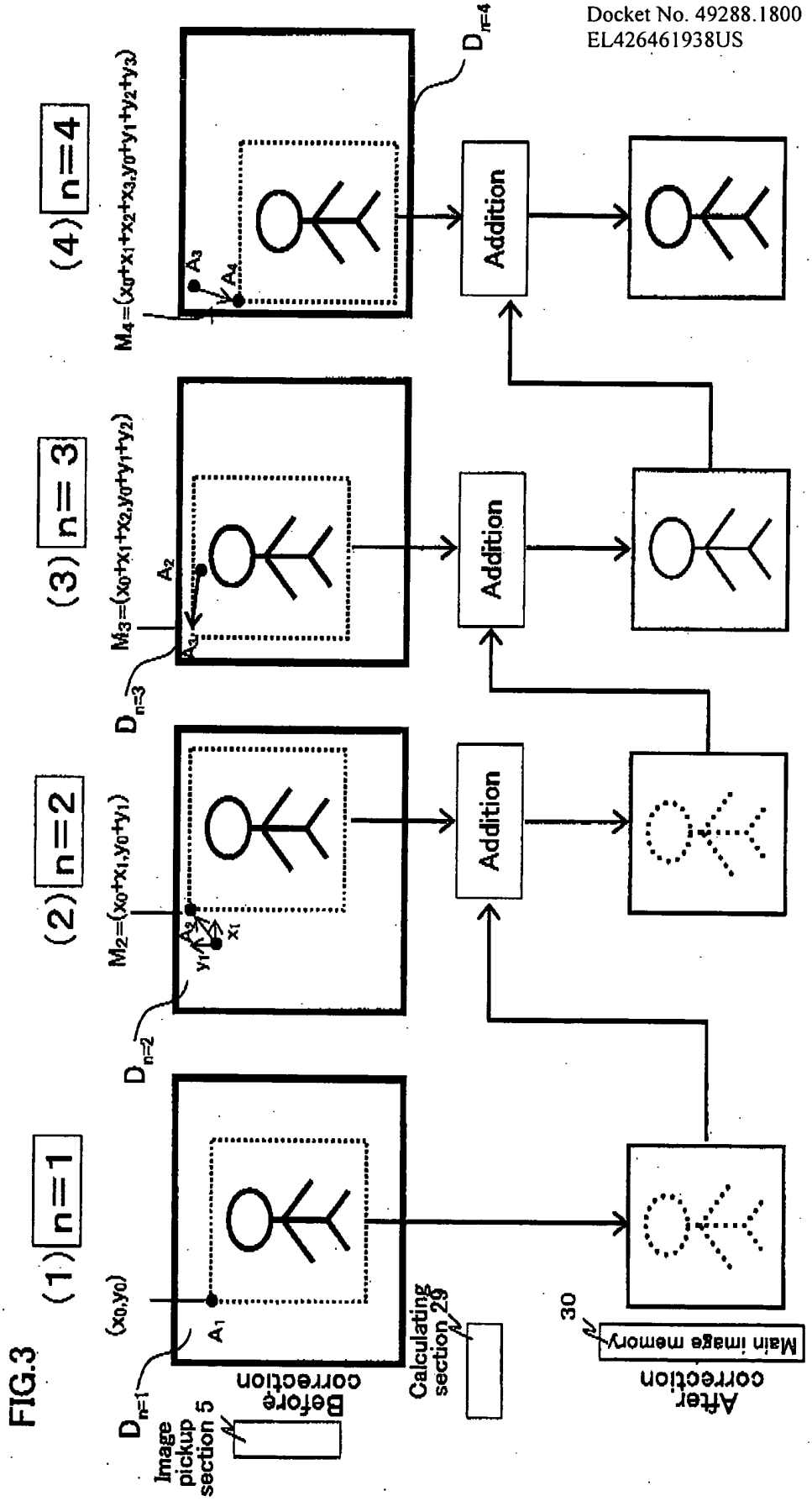

(x_1, y_1)
Motion vector output section
15
Shaking motion detecting section
16
First memory
17
Second memory
18
Calculating section
$t=t_{n-1}$
$t=t_n$
D_{n-1}
D_n
x_1
y_1

FIG.2

FIG.3


(1) n=1
(2) n=2
(3) n=3
(4) n=4
(x_0,y_0)
$M_2=(x_0+x_1,y_0+y_1)$
$M_3=(x_0+x_1+x_2,y_0+y_1+y_2)$
$M_4=(x_0+x_1+x_2+x_3,y_0+y_1+y_2+y_3)$
A_1
A_2
A_3
A_4
x_1
y_1
$D_{n=1}$
$D_{n=2}$
$D_{n=3}$
$D_{n=4}$
Addition
Addition
Addition
Image pickup section 5
Before correction
Calculating section 29
Main image memory
30
After correction

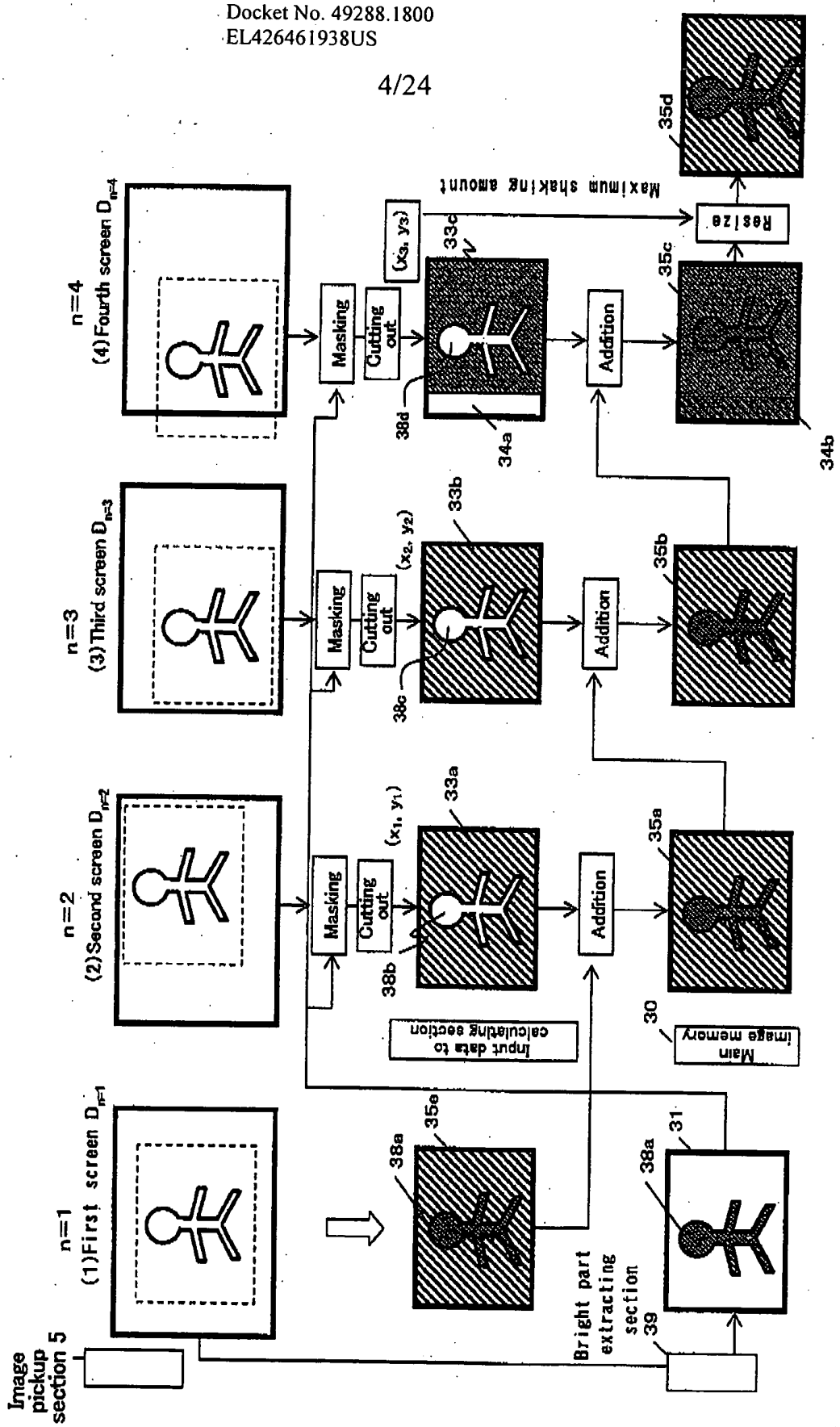

n=4
(4)Fourth screen $D_{n=4}$
n=3
(3)Third screen $D_{n=3}$
n=2
(2)Second screen $D_{n=2}$
n=1
(1)First screen $D_{n=1}$
Masking
Cutting out
Addition
Resize
Maximum shaking amount
(x_3, y_3)
(x_2, y_2)
(x_1, y_1)
33a
33b
33c
34a
34b
35a
35b
35c
35d
38a
38b
38c
38d
Input data to calculating section
Main image memory
30
31
Bright part extracting section
39
Image pickup section 5

FIG.4

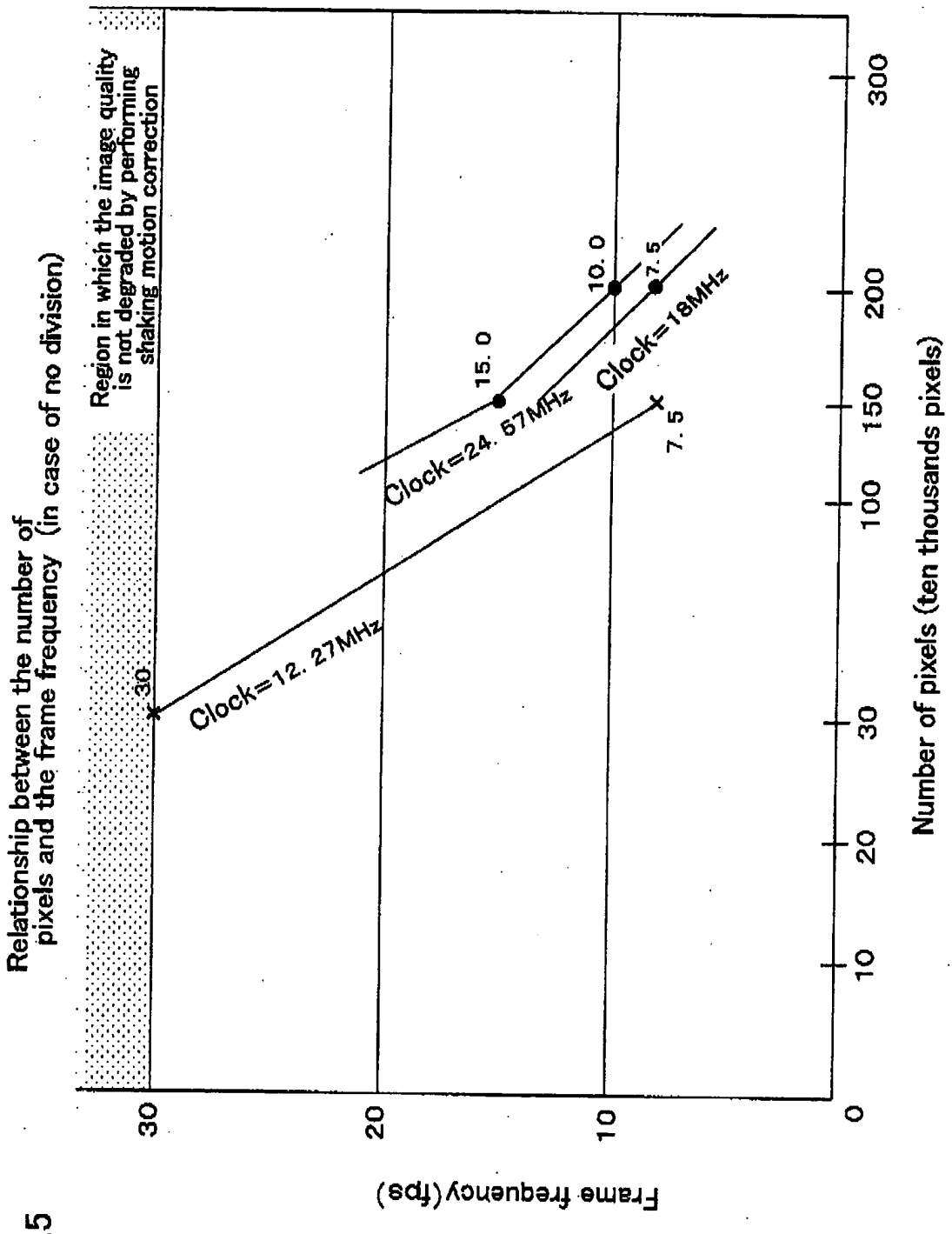

Relationship between the number of pixels and the frame frequency (in case of no division)
Region in which the image quality is not degraded by performing shaking motion correction
Clock=12.27MHz
Clock=24.57MHz
Clock=18MHz
30
15.0
10.0
7.5
7.5
Frame frequency (fps)
30
20
10
0
10
20
30
100
150
200
300
Number of pixels (ten thousands pixels)

FIG.5

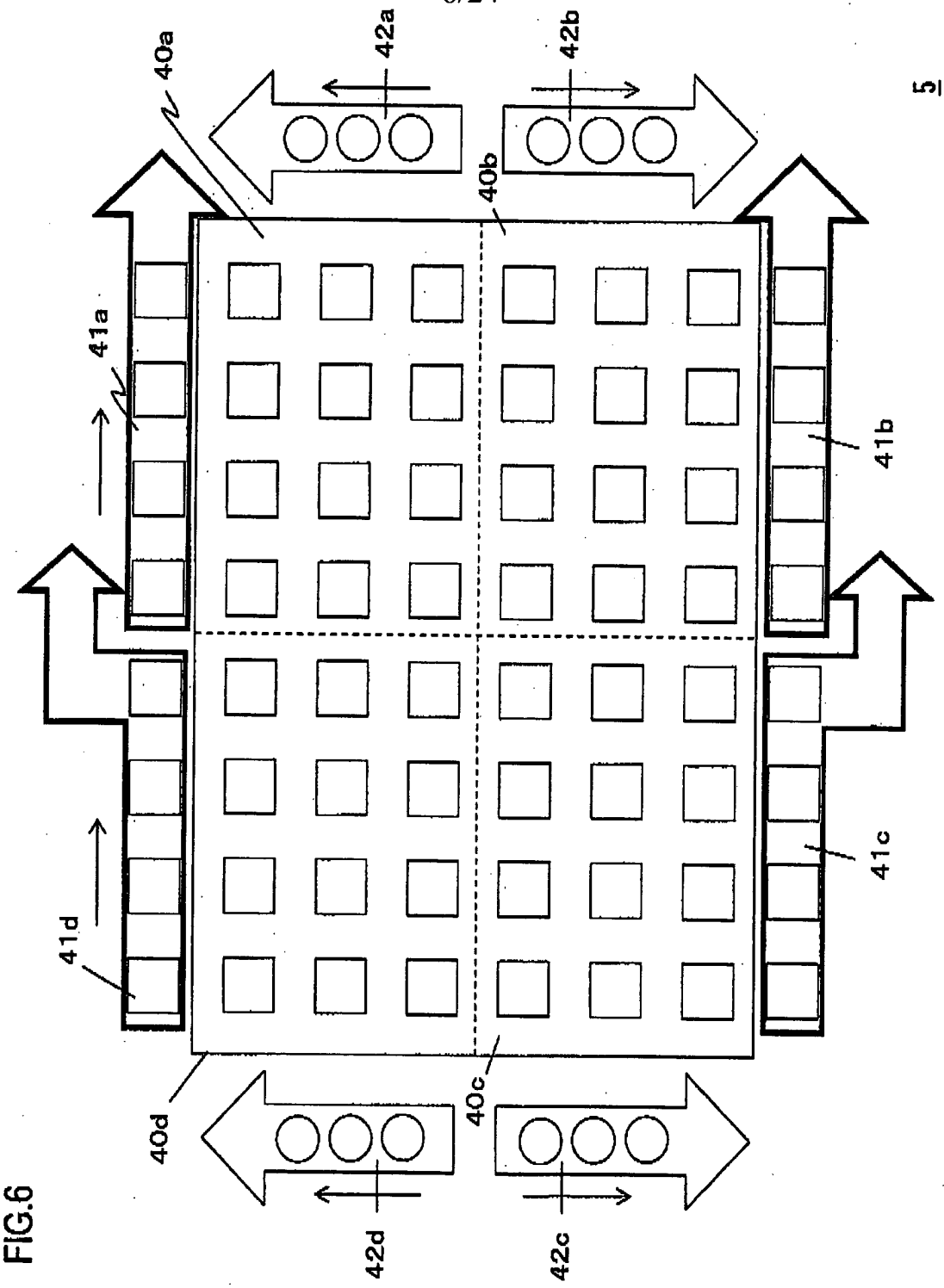


FIG.6

FIG.7

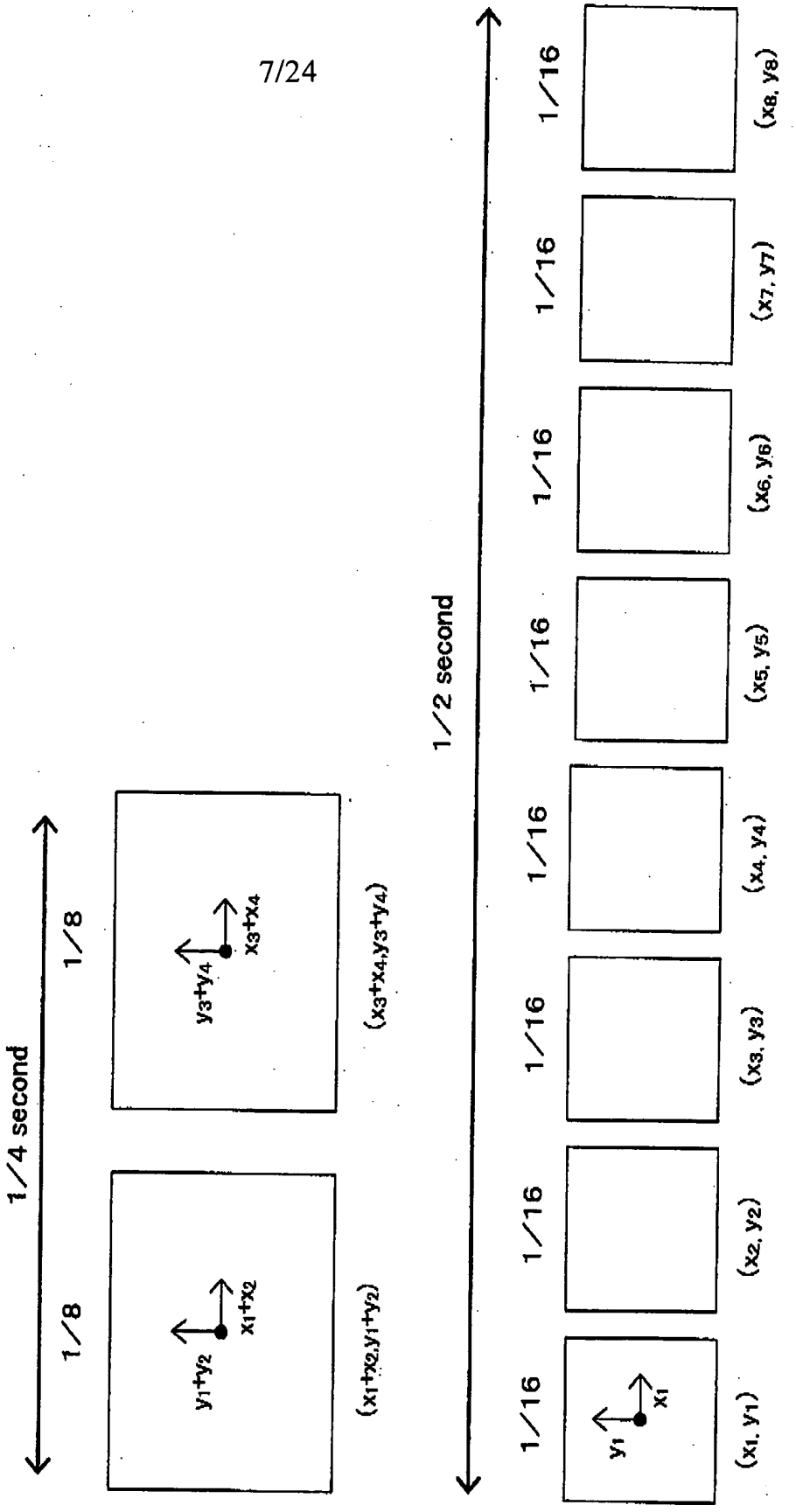

1/4 second
1/8
1/8
y_1+y_2
x_1+x_2
(x_1+x_2, y_1+y_2)
y_3+y_4
x_3+x_4
(x_3+x_4, y_3+y_4)
1/2 second
1/16
y_1
x_1
(x_1, y_1)
1/16
(x_2, y_2)
1/16
(x_3, y_3)
1/16
(x_4, y_4)
1/16
(x_5, y_5)
1/16
(x_6, y_6)
1/16
(x_7, y_7)
1/16
(x_8, y_8)

FIG.8

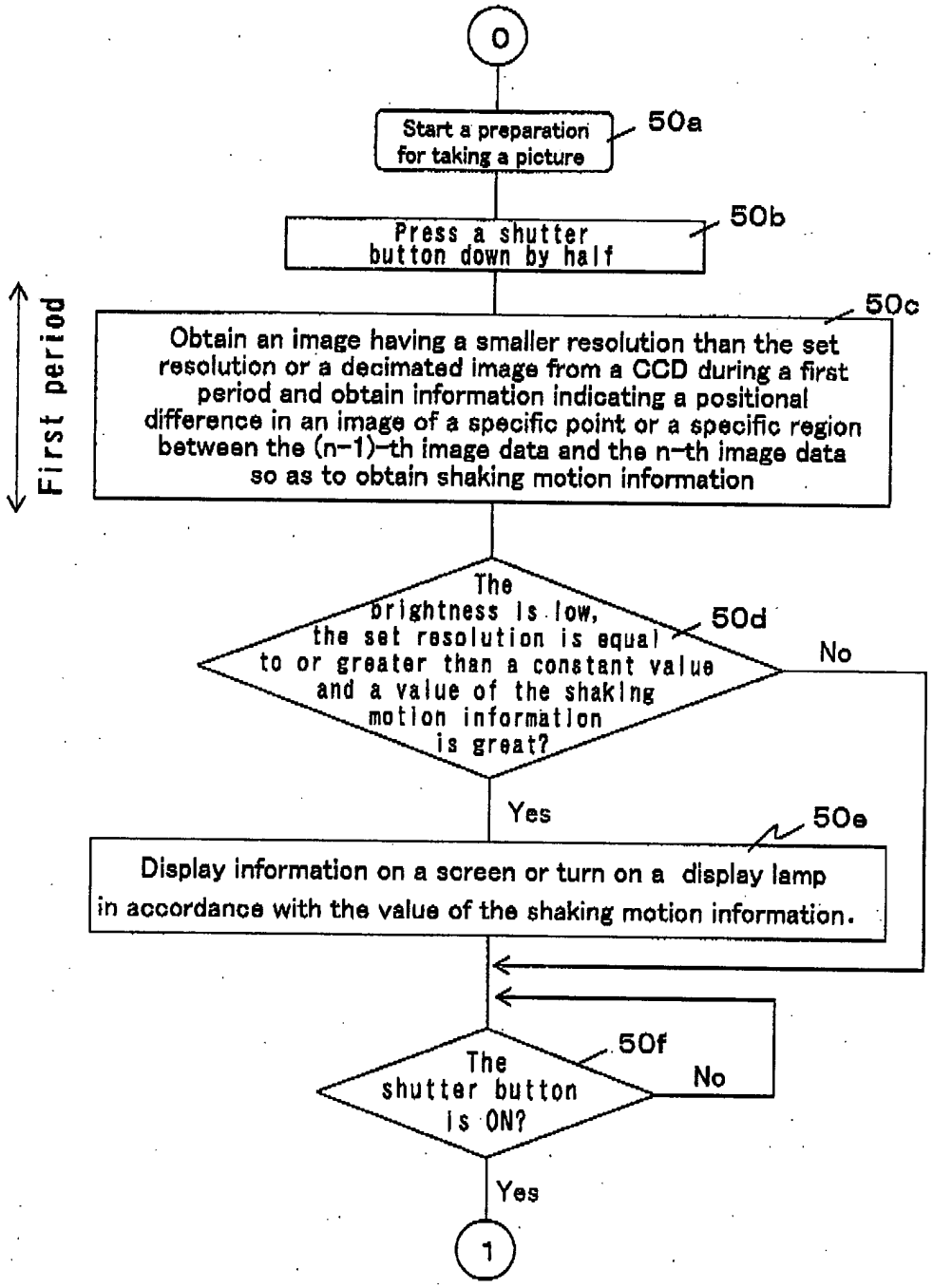

0
Start a preparation for taking a picture
50a
Press a shutter button down by half
50b
First period
Obtain an image having a smaller resolution than the set resolution or a decimated image from a CCD during a first period and obtain information indicating a positional difference in an image of a specific point or a specific region between the (n-1)-th image data and the n-th image data so as to obtain shaking motion information
50c
The brightness is low, the set resolution is equal to or greater than a constant value and a value of the shaking motion information is great?
50d
No
Yes
Display information on a screen or turn on a display lamp in accordance with the value of the shaking motion information.
50e
The shutter button is ON?
50f
No
Yes
1

FIG.9

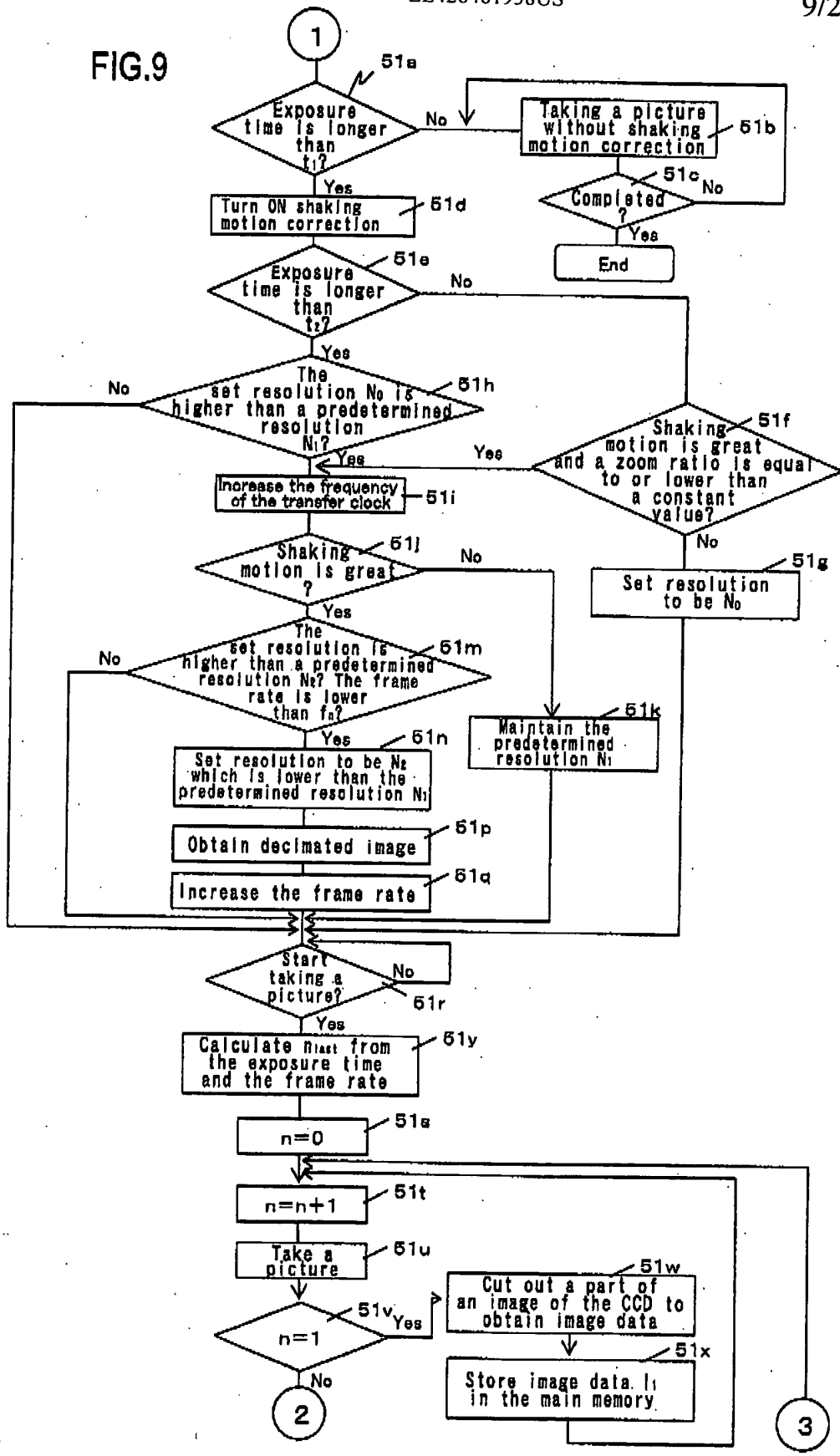

1
51a
Exposure time is longer than t1?
No
Yes
Taking a picture without shaking motion correction
51b
51c
Completed ?
No
Yes
End
Turn ON shaking motion correction
51d
51e
Exposure time is longer than t2?
No
Yes
51f
Shaking motion is great and a zoom ratio is equal to or lower than a constant value?
Yes
No
51g
Set resolution to be N0
51h
The set resolution N0 is higher than a predetermined resolution N1?
No
Yes
Increase the frequency of the transfer clock
51i
51j
Shaking motion is great ?
No
Yes
51k
Maintain the predetermined resolution N1
51m
The set resolution is higher than a predetermined resolution N2? The frame rate is lower than f2?
No
Yes
51n
Set resolution to be N2 which is lower than the predetermined resolution N1
51p
Obtain decimated image
51q
Increase the frame rate
Start taking a picture?
No
51r
Yes
51y
Calculate nlast from the exposure time and the frame rate
51s
n=0
51t
n=n+1
51u
Take a picture
51v
n=1
Yes
No
51w
Cut out a part of an image of the CCD to obtain image data
51x
Store image data I1 in the main memory
2
3

FIG.10

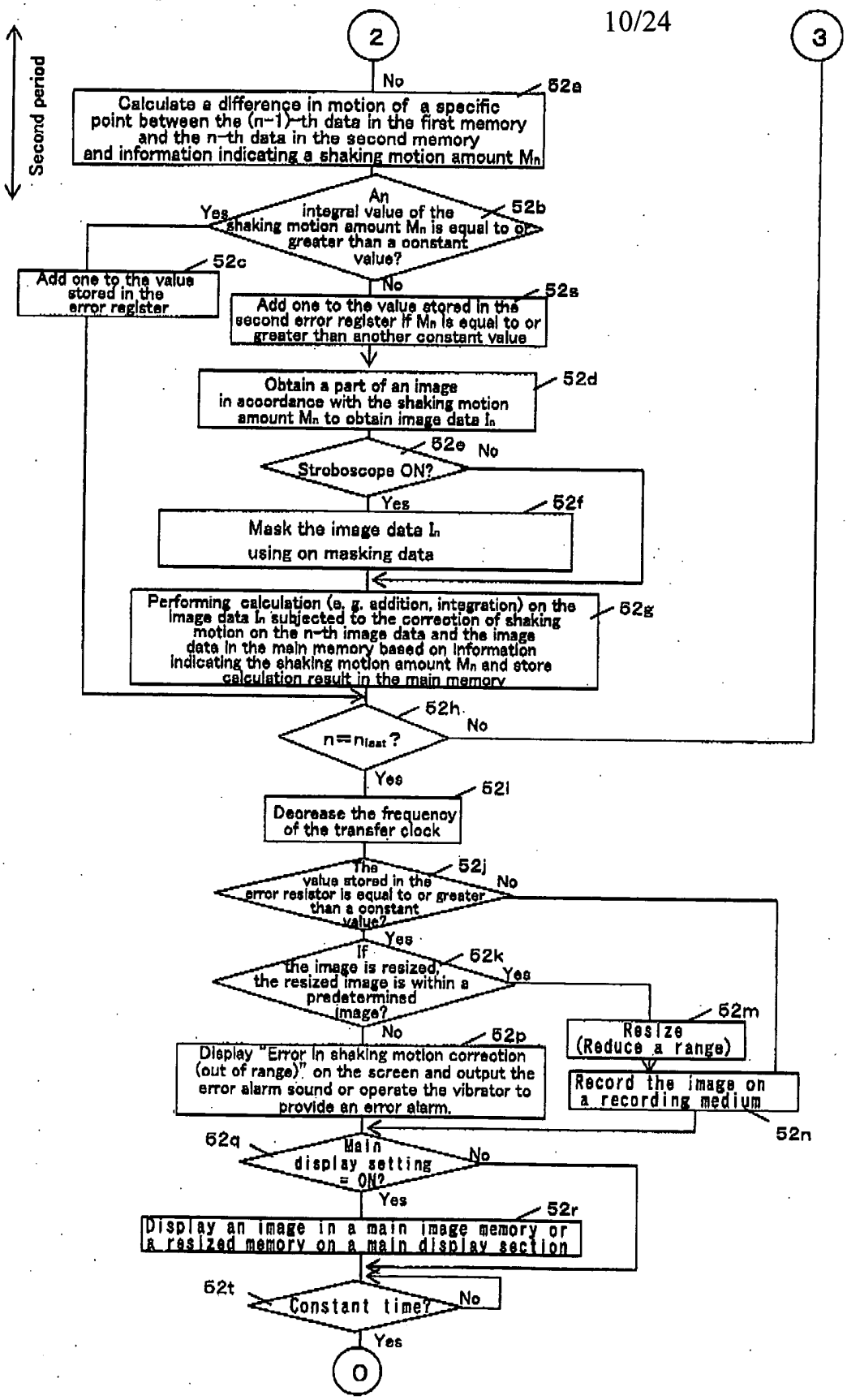

2
3
Second period
No
52a
Calculate a difference in motion of a specific point between the (n-1)-th data in the first memory and the n-th data in the second memory and information indicating a shaking motion amount Mn
An integral value of the shaking motion amount Mn is equal to or greater than a constant value?
52b
Yes
No
52c
Add one to the value stored in the error register
52e
Add one to the value stored in the second error register if Mn is equal to or greater than another constant value
52s
Obtain a part of an image in accordance with the shaking motion amount Mn to obtain image data In
52d
Stroboscope ON?
52e
No
Yes
52f
Mask the image data In using on masking data
Performing calculation (e. g. addition, integration) on the image data In subjected to the correction of shaking motion on the n-th image data and the image data in the main memory based on information indicating the shaking motion amount Mn and store calculation result in the main memory
52g
n=nlast?
52h
No
Yes
Decrease the frequency of the transfer clock
52i
The value stored in the error resistor is equal to or greater than a constant value?
52j
No
Yes
If the image is resized, the resized image is within a predetermined image?
52k
Yes
No
52m
Resize (Reduce a range)
Display "Error in shaking motion correction (out of range)" on the screen and output the error alarm sound or operate the vibrator to provide an error alarm.
52p
Record the image on a recording medium
52n
Main display setting = ON?
52q
No
Yes
Display an image in a main image memory or a resized memory on a main display section
52r
Constant time?
52t
No
Yes
0

FIG.11

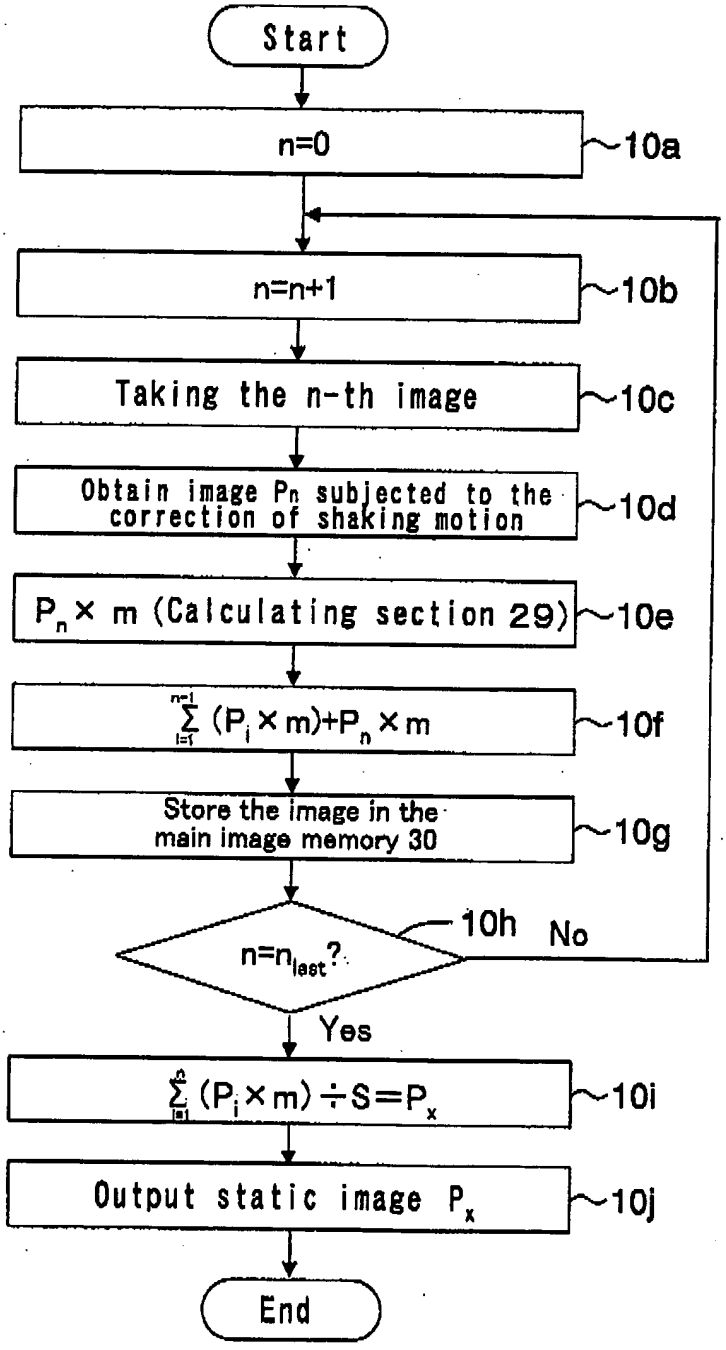

Start
n=0
10a
n=n+1
10b
Taking the n-th image
10c
Obtain image Pn subjected to the correction of shaking motion
10d
Pn × m (Calculating section 29)
10e
$\sum_{i=1}^{n-1}(P_i \times m)+P_n \times m$
10f
Store the image in the main image memory 30
10g
$n=n_{last}$?
10h
No
Yes
$\sum_{i=1}^{n}(P_i \times m) \div S = P_x$
10i
Output static image P_x
10j
End

FIG.12

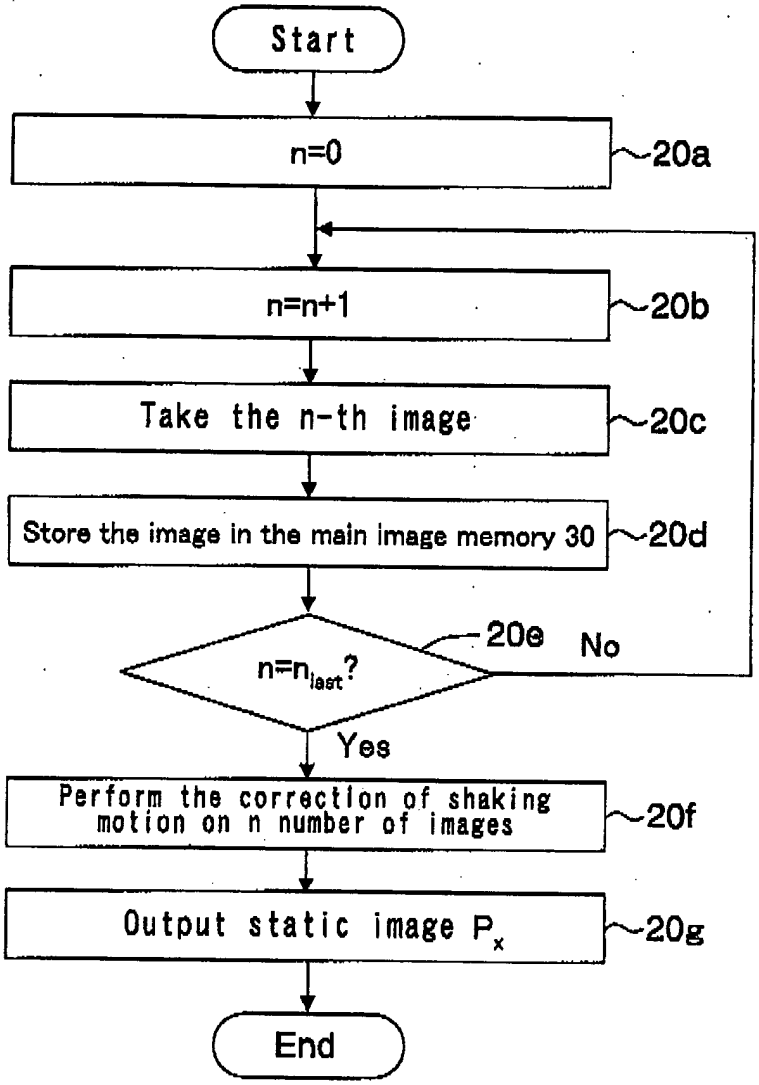

Start
n=0
20a
n=n+1
20b
Take the n-th image
20c
Store the image in the main image memory 30
20d
n=n_last?
20e
No
Yes
Perform the correction of shaking motion on n number of images
20f
Output static image P_x
20g
End

FIG.13

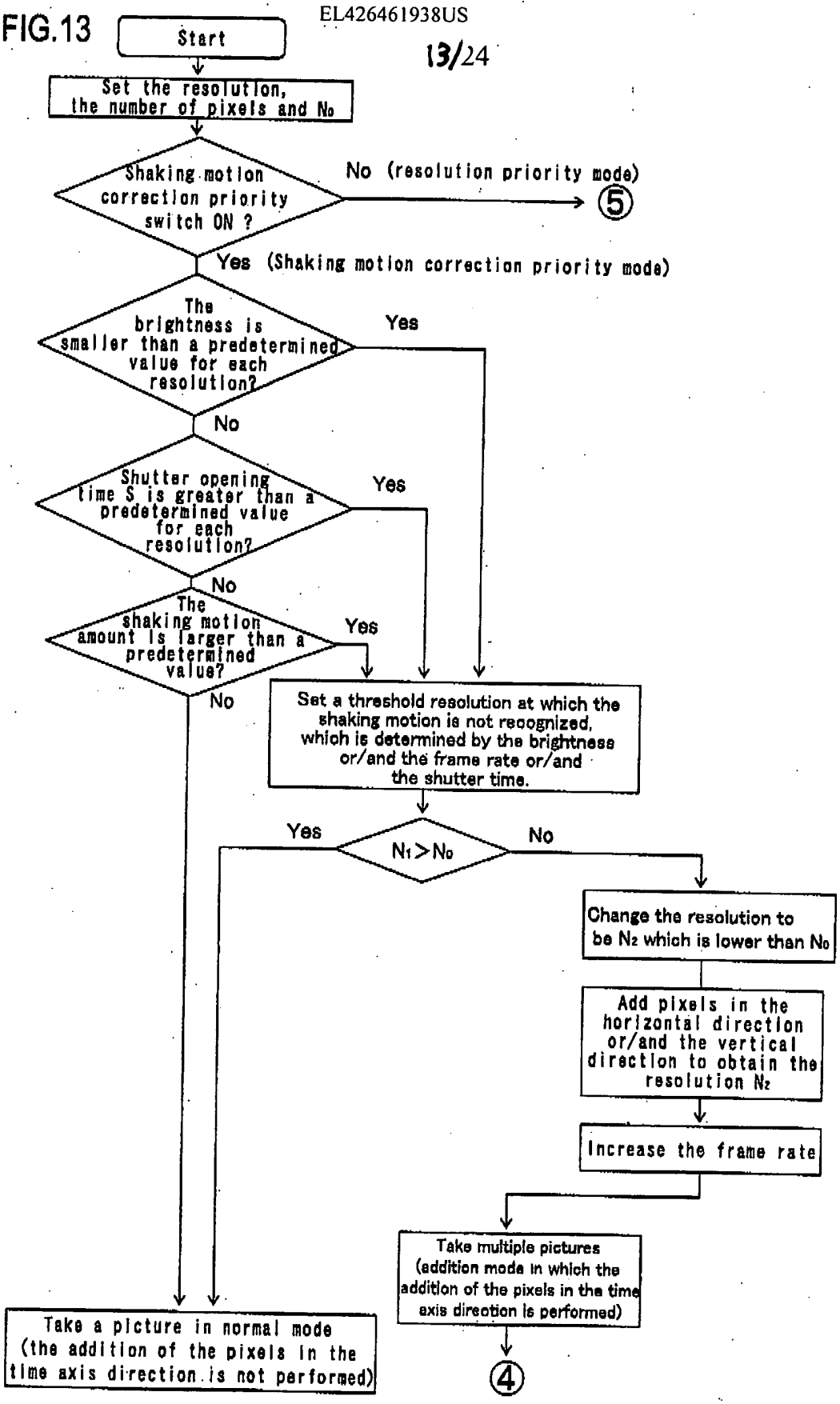
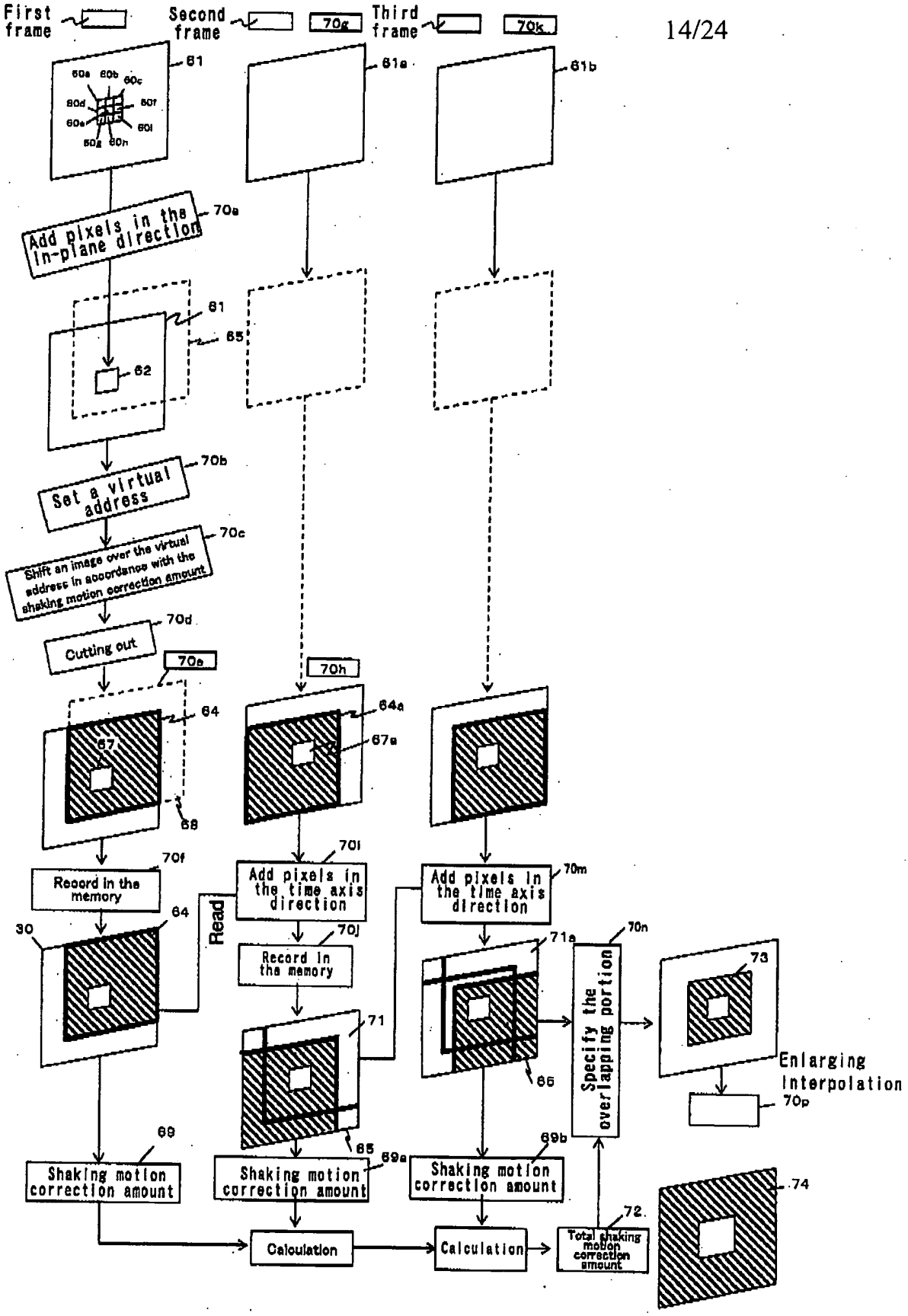

Start
Set the resolution, the number of pixels and N0
Shaking motion correction priority switch ON ?
No (resolution priority mode)
⑤
Yes (Shaking motion correction priority mode)
The brightness is smaller than a predetermined value for each resolution?
Yes
No
Shutter opening time S is greater than a predetermined value for each resolution?
Yes
No
The shaking motion amount is larger than a predetermined value?
Yes
No
Set a threshold resolution at which the shaking motion is not recognized, which is determined by the brightness or/and the frame rate or/and the shutter time.
Yes
N1>N0
No
Change the resolution to be N2 which is lower than N0
Add pixels in the horizontal direction or/and the vertical direction to obtain the resolution N2
Increase the frame rate
Take multiple pictures (addition mode in which the addition of the pixels in the time axis direction is performed)
④
Take a picture in normal mode (the addition of the pixels in the time axis direction is not performed)

FIG.14


First frame
Second frame
70g
Third frame
70k
61
61a
61b
60a 60b 60c
60d 60f
60e 60i
60g 60h
Add pixels in the in-plane direction
70a
61
65
62
Set a virtual address
70b
Shift an image over the virtual address in accordance with the shaking motion correction amount
70c
Cutting out
70d
70e
70h
64
64a
67
67a
68
70f
Record in the memory
70i
Add pixels in the time axis direction
70m
Read
64
30
70j
Record in the memory
71
71a
70n
Specify the overlapping portion
73
Enlarging Interpolation
70p
65
69
69a
69b
Shaking motion correction amount
Shaking motion correction amount
Shaking motion correction amount
Calculation
Calculation
72
Total shaking motion correction amount
74

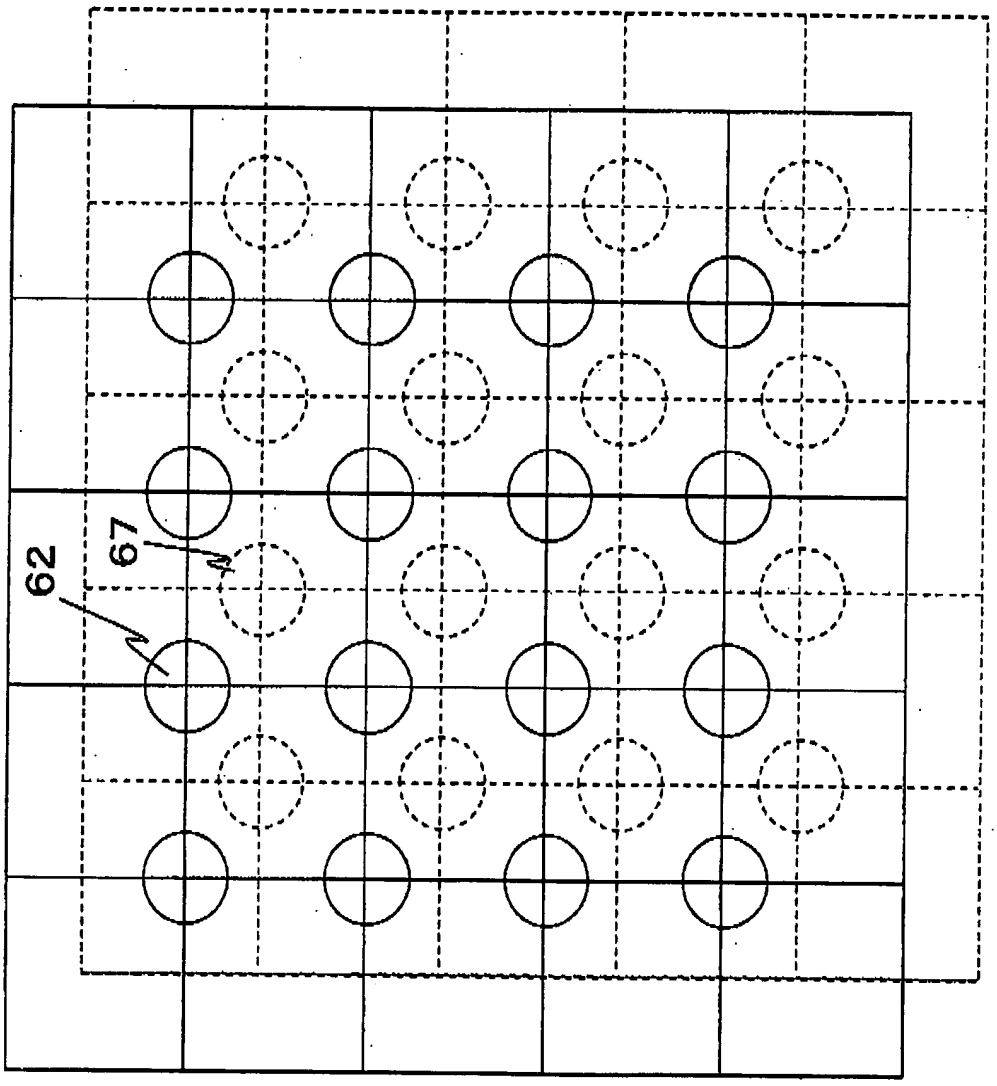
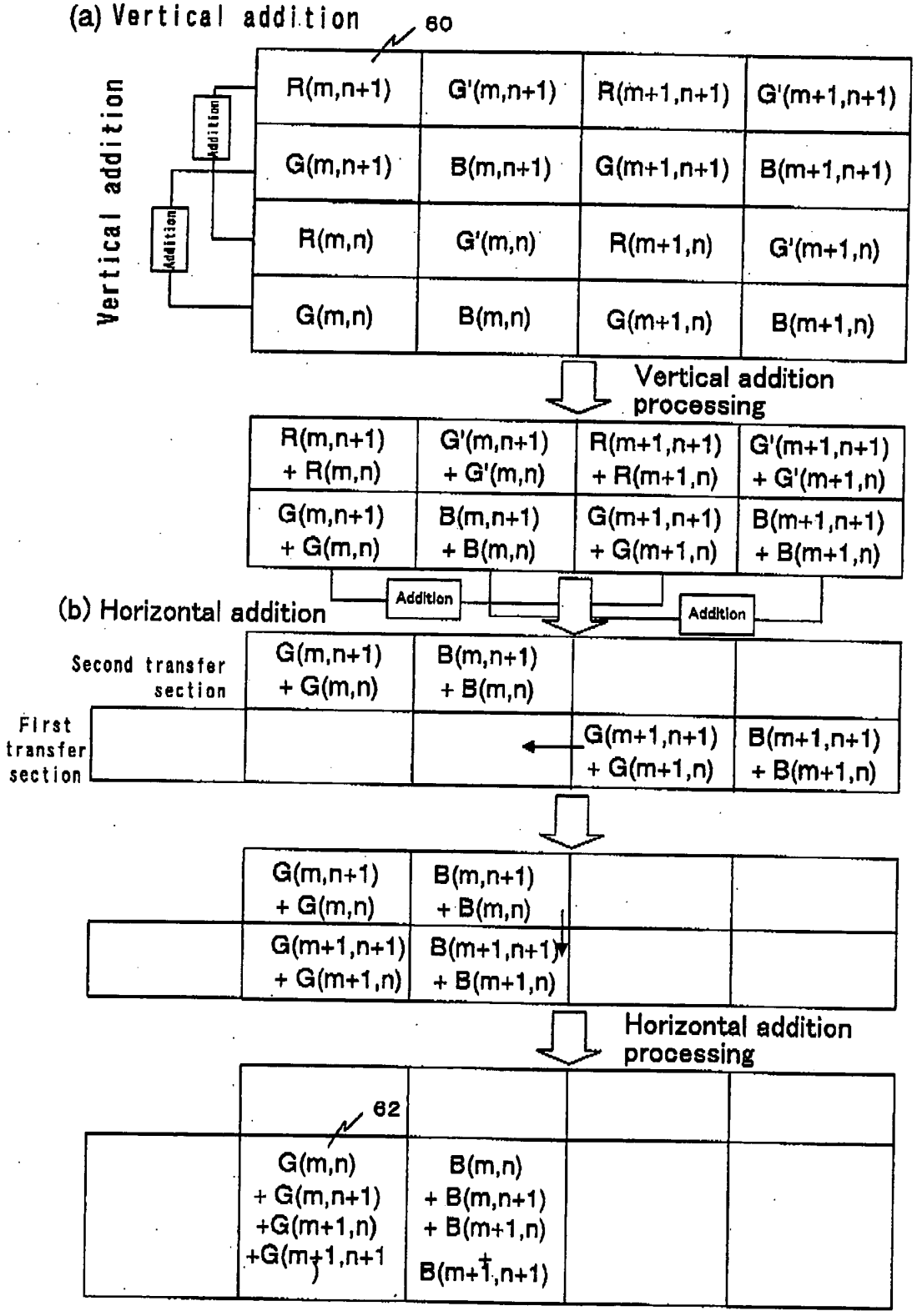


FIG.15

FIG.16


(a) Vertical addition
60
Vertical addition
Addition
Addition
R(m,n+1)
G'(m,n+1)
R(m+1,n+1)
G'(m+1,n+1)
G(m,n+1)
B(m,n+1)
G(m+1,n+1)
B(m+1,n+1)
R(m,n)
G'(m,n)
R(m+1,n)
G'(m+1,n)
G(m,n)
B(m,n)
G(m+1,n)
B(m+1,n)
Vertical addition processing
R(m,n+1) + R(m,n)
G'(m,n+1) + G'(m,n)
R(m+1,n+1) + R(m+1,n)
G'(m+1,n+1) + G'(m+1,n)
G(m,n+1) + G(m,n)
B(m,n+1) + B(m,n)
G(m+1,n+1) + G(m+1,n)
B(m+1,n+1) + B(m+1,n)
Addition
Addition
(b) Horizontal addition
Second transfer section
First transfer section
G(m,n+1) + G(m,n)
B(m,n+1) + B(m,n)
G(m+1,n+1) + G(m+1,n)
B(m+1,n+1) + B(m+1,n)
Horizontal addition processing
62
G(m,n) + G(m,n+1) +G(m+1,n) +G(m+1,n+1)
B(m,n) + B(m,n+1) + B(m+1,n) + B(m+1,n+1)

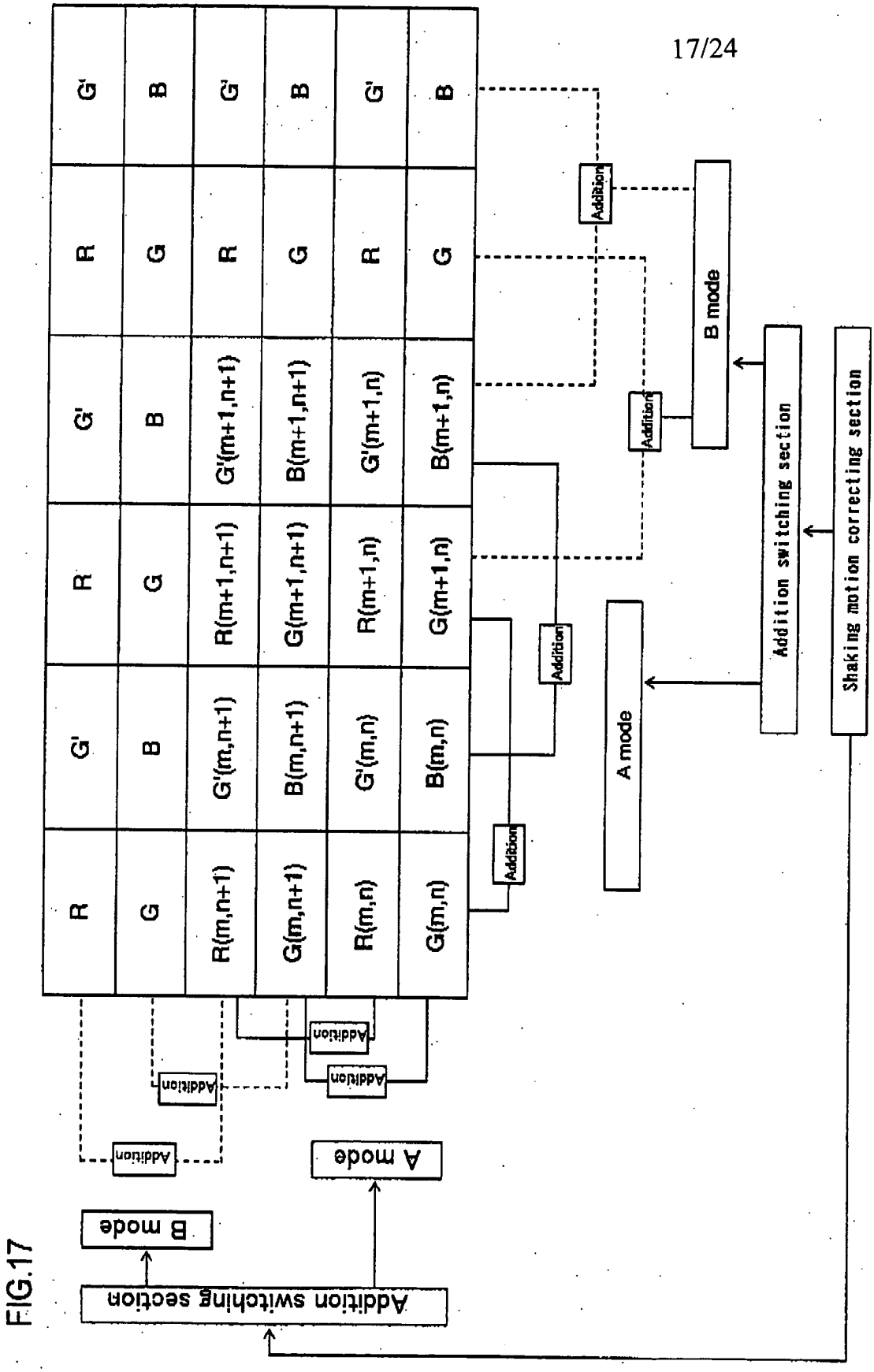
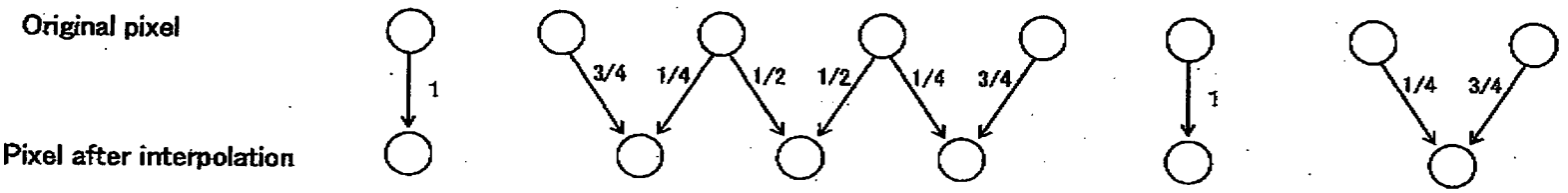

G'
B
G'
B
G'
B
R
G
R
G
R
G
G'
B
G'(m+1,n+1)
B(m+1,n+1)
G'(m+1,n)
B(m+1,n)
R
G
R(m+1,n+1)
G(m+1,n+1)
R(m+1,n)
G(m+1,n)
G'
B
G'(m,n+1)
B(m,n+1)
G'(m,n)
B(m,n)
R
G
R(m,n+1)
G(m,n+1)
R(m,n)
G(m,n)
Addition
Addition
Addition
Addition
Addition
Addition
Addition
Addition
B mode
A mode
Addition switching section
Shaking motion correcting section
B mode
A mode
Addition switching section

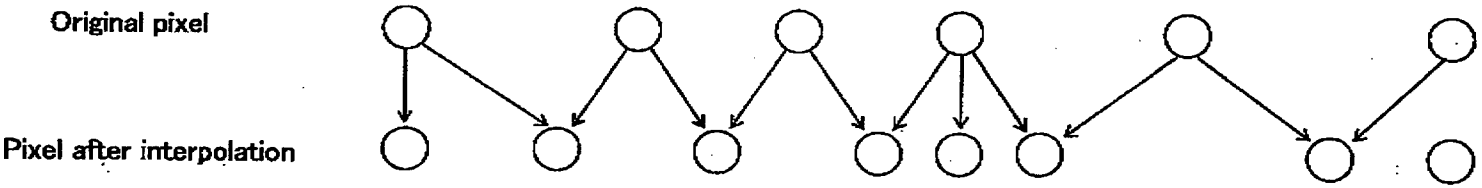
FIG.17

FIG.18

(a) Principle of interpolation (Reduction)



(b) Principle of interpolation (Enlargement)



(c) Shaking motion correction with high resolution

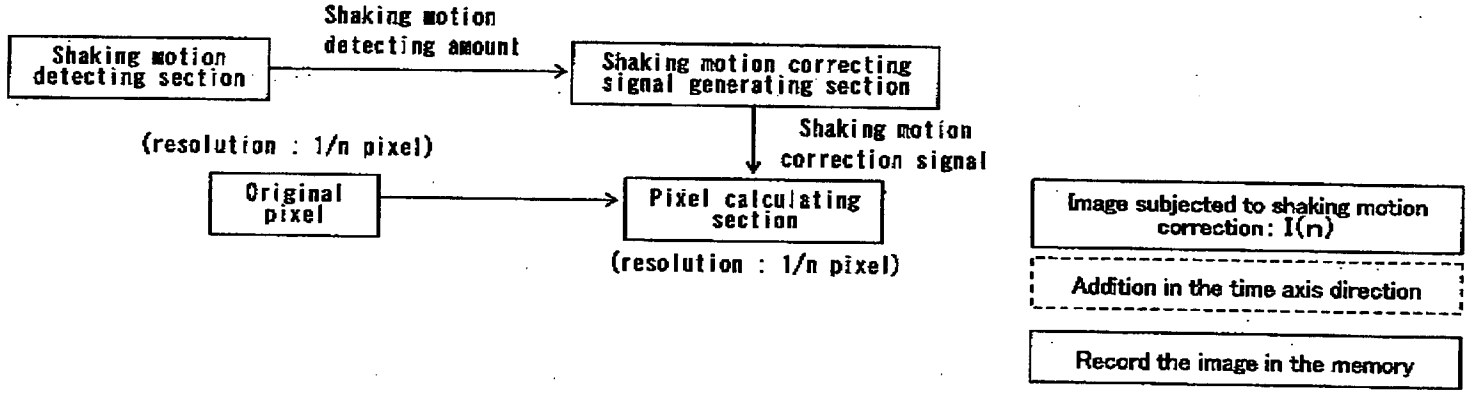


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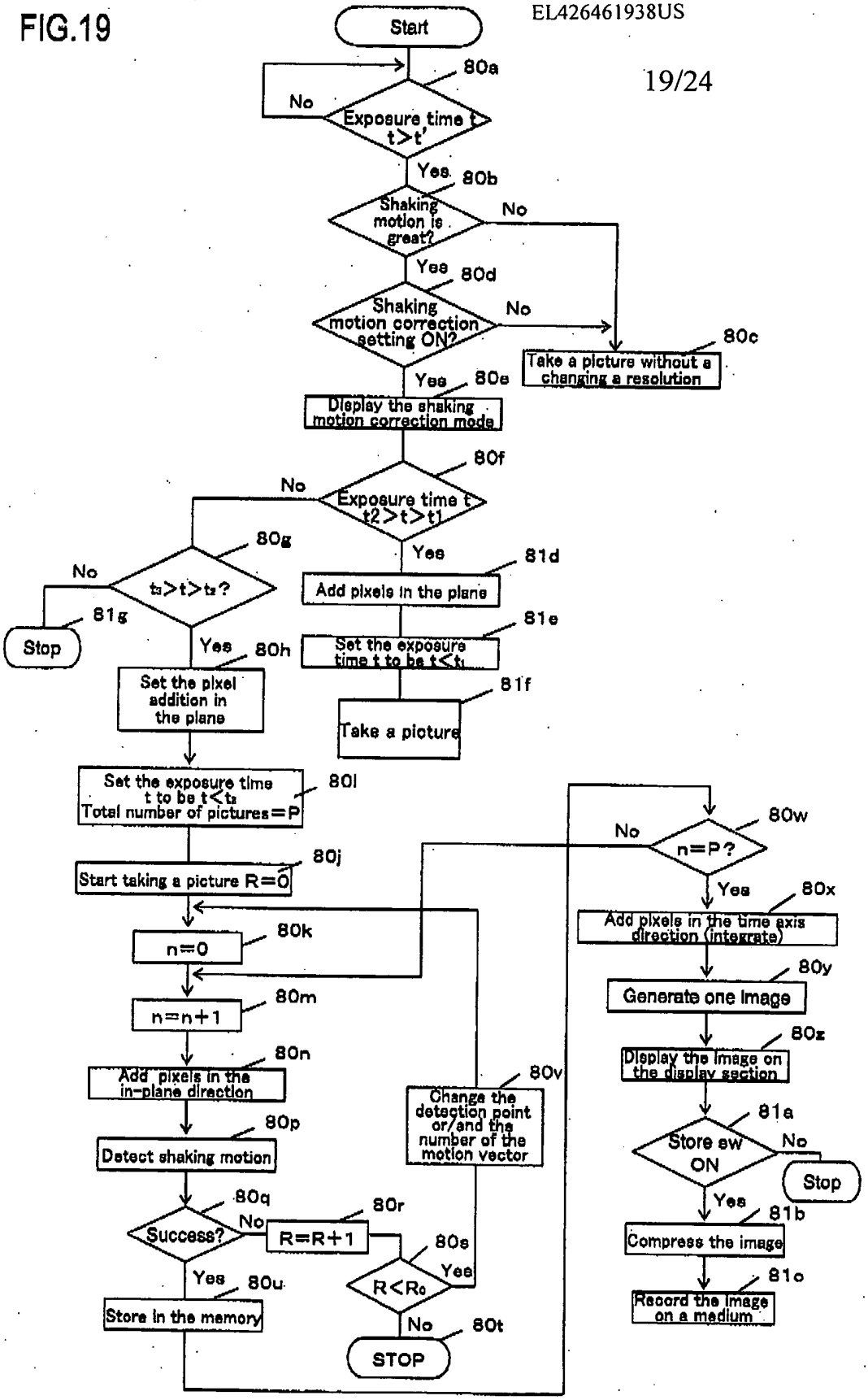
FIG.19


Start
80a
No
Exposure time t
t>t'
Yes
80b
Shaking motion is great?
No
Yes
80d
Shaking motion correction setting ON?
No
80c
Take a picture without a changing a resolution
Yes
80e
Display the shaking motion correction mode
80f
No
Exposure time t
t2>t>t1
Yes
81d
Add pixels in the plane
81e
Set the exposure time t to be t<t1
81f
Take a picture
80g
No
t3>t>t2?
81g
Stop
Yes
80h
Set the pixel addition in the plane
Set the exposure time t to be t<t3
Total number of pictures=P
80l
80j
Start taking a picture R=0
80k
n=0
80m
n=n+1
80n
Add pixels in the in-plane direction
80p
Detect shaking motion
80q
Success?
No
80r
R=R+1
80s
R<R0
Yes
No
80t
STOP
Yes
80u
Store in the memory
80v
Change the detection point or/and the number of the motion vector
80w
No
n=P?
Yes
80x
Add pixels in the time axis direction (integrate)
80y
Generate one Image
80z
Display the image on the display section
81a
Store ew ON
No
Stop
Yes
81b
Compress the image
81c
Record the image on a medium

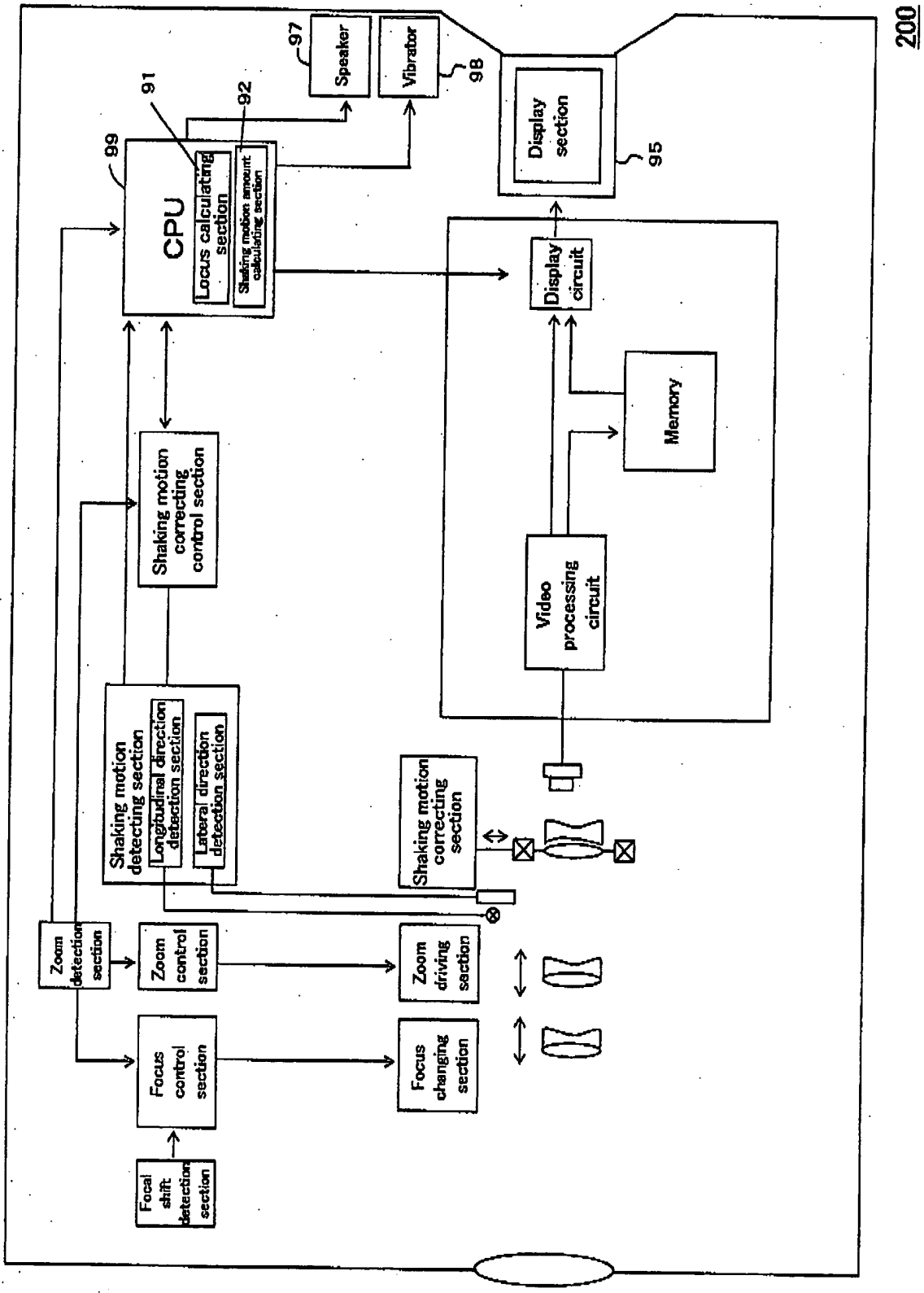

200
97
Speaker
Vibrator
98
91
92
99
CPU
Locus calculating section
Shaking motion amount calculating section
Display section
95
Display circuit
Memory
Video processing circuit
Shaking motion correcting control section
Shaking motion detecting section
Longitudinal direction detection section
Lateral direction detection section
Shaking motion correcting section
Zoom detection section
Zoom control section
Zoom driving section
Focus control section
Focus changing section
Focal shift detection section

FIG.20

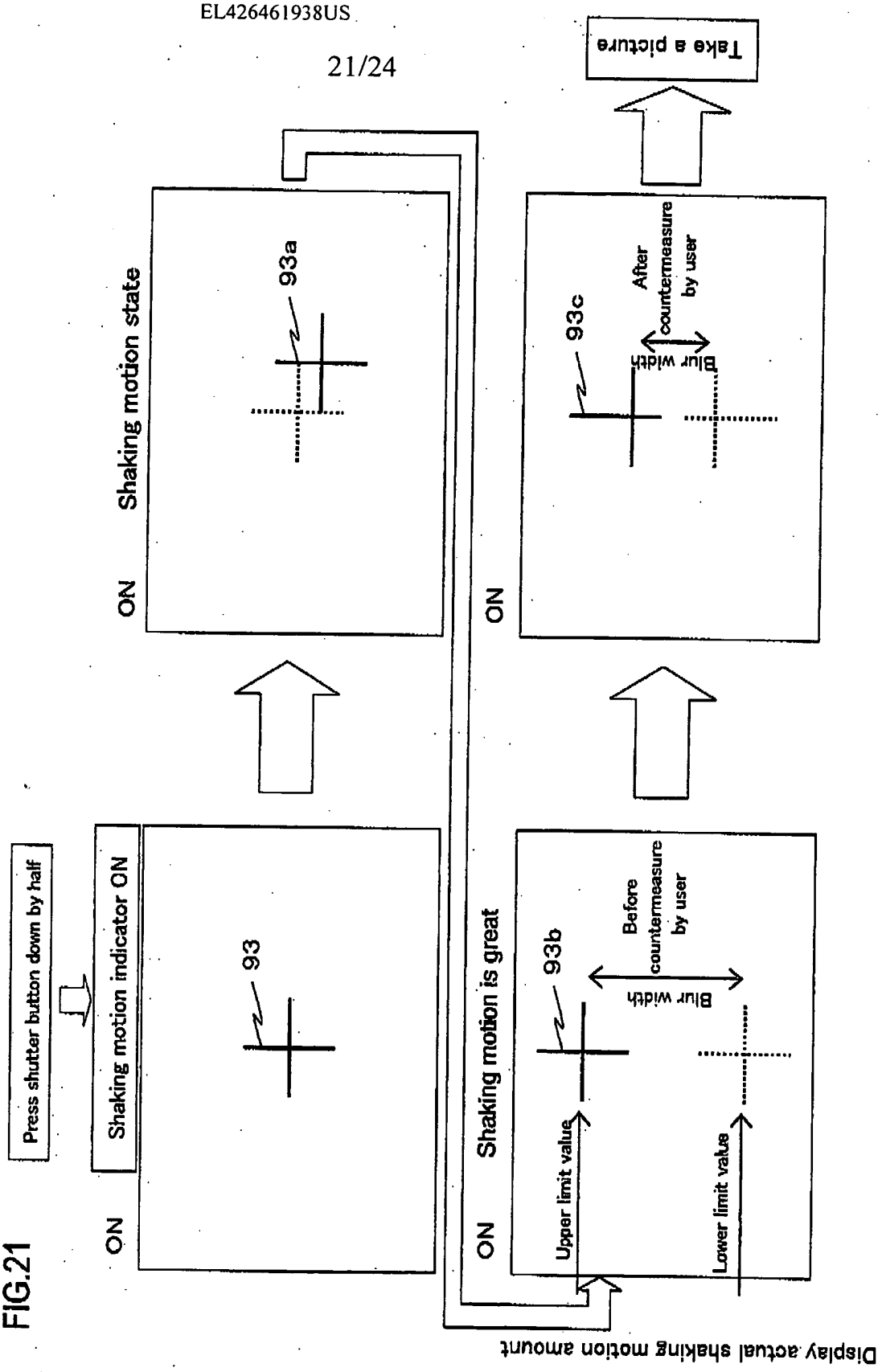

Press shutter button down by half
Shaking motion indicator ON
ON
93
Shaking motion is great
ON
93b
Before countermeasure by user
Blur width
Upper limit value
Lower limit value
Shaking motion state
ON
93a
ON
93c
After countermeasure by user
Blur width
Take a picture
Display actual shaking motion amount

FIG.21

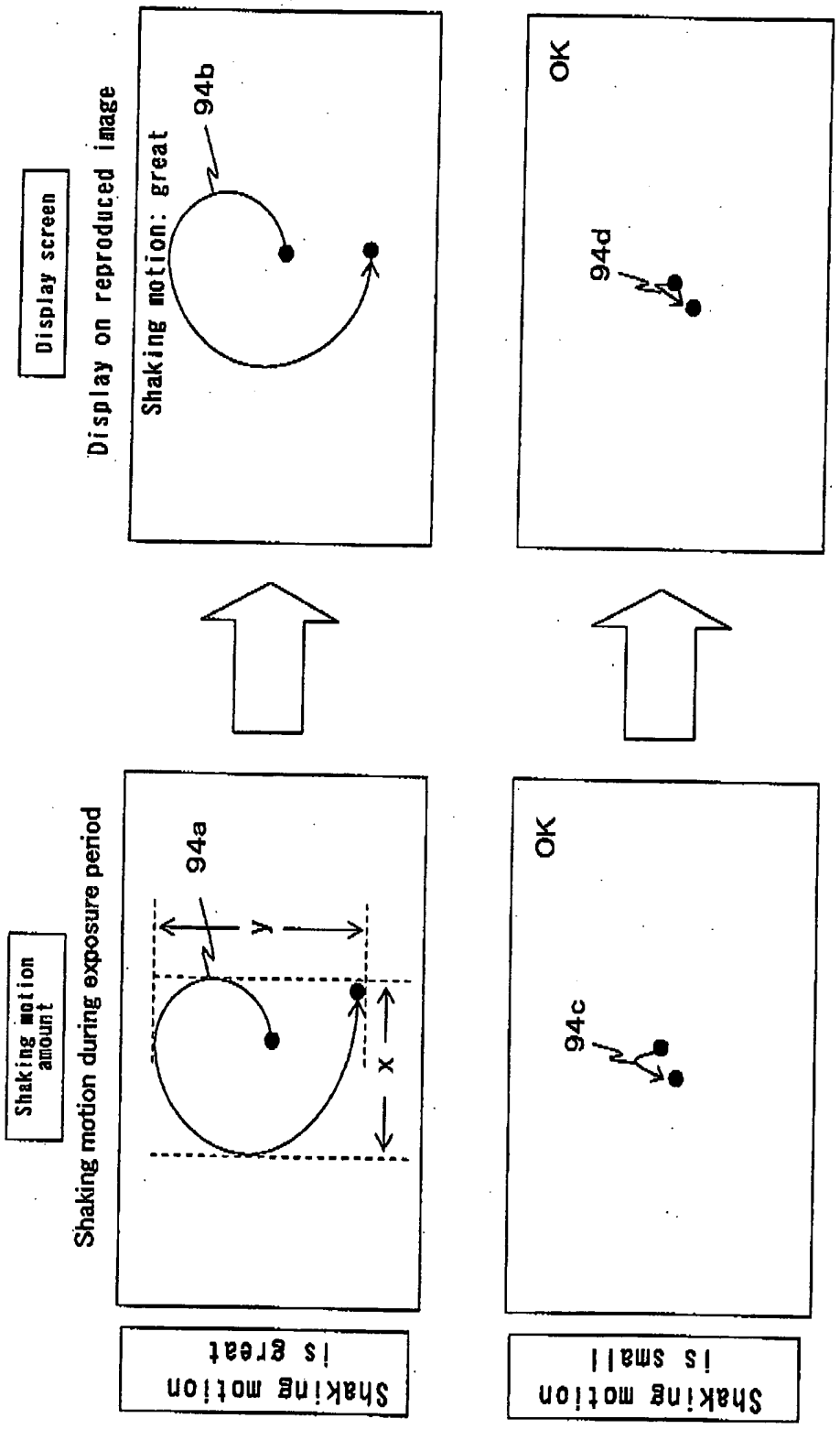
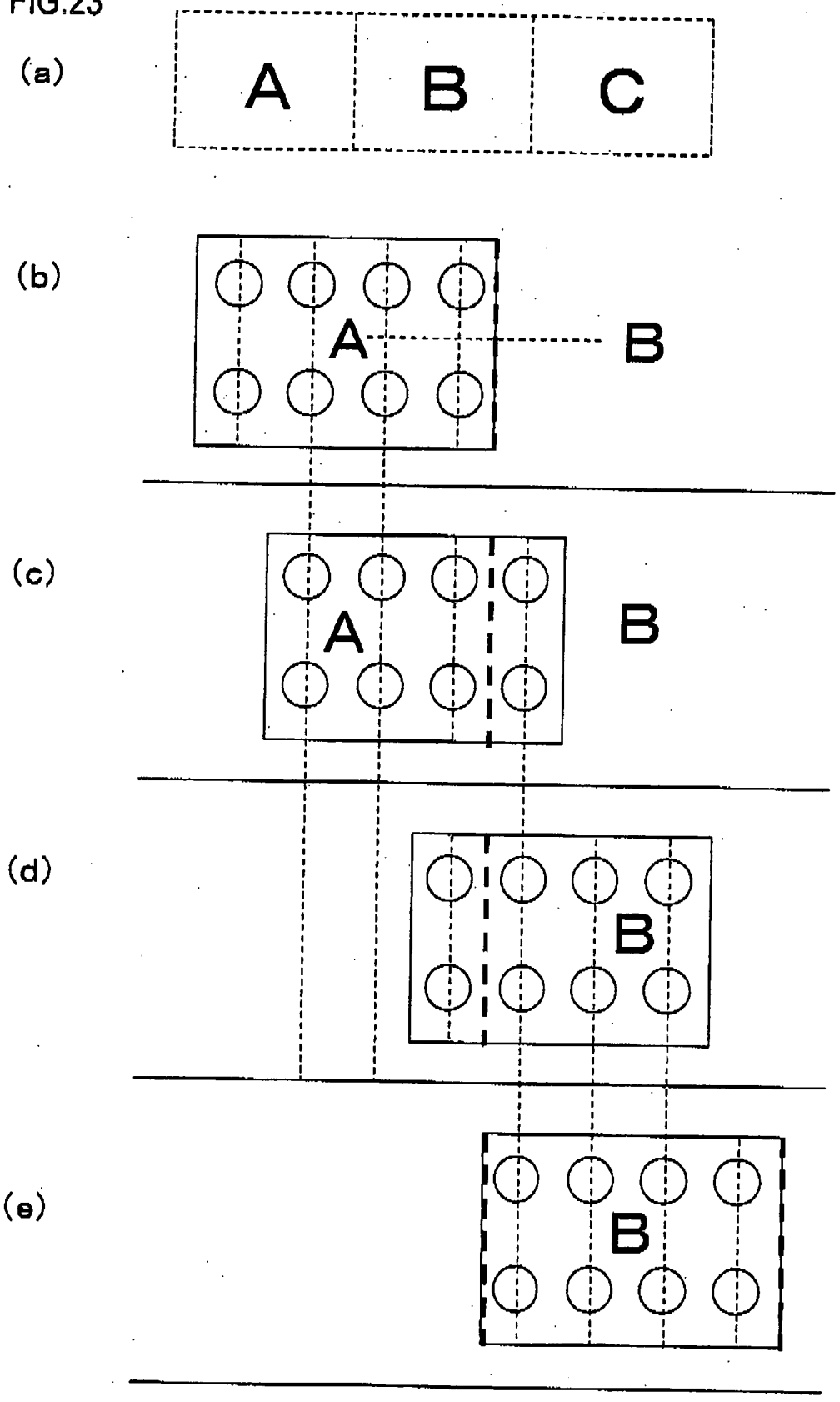

Shaking motion is great
Shaking motion is small
Shaking motion amount
Shaking motion during exposure period
94a
y
x
94c
OK
Display screen
Display on reproduced image
Shaking motion: great
94b
94d
OK

FIG.22

FIG.23



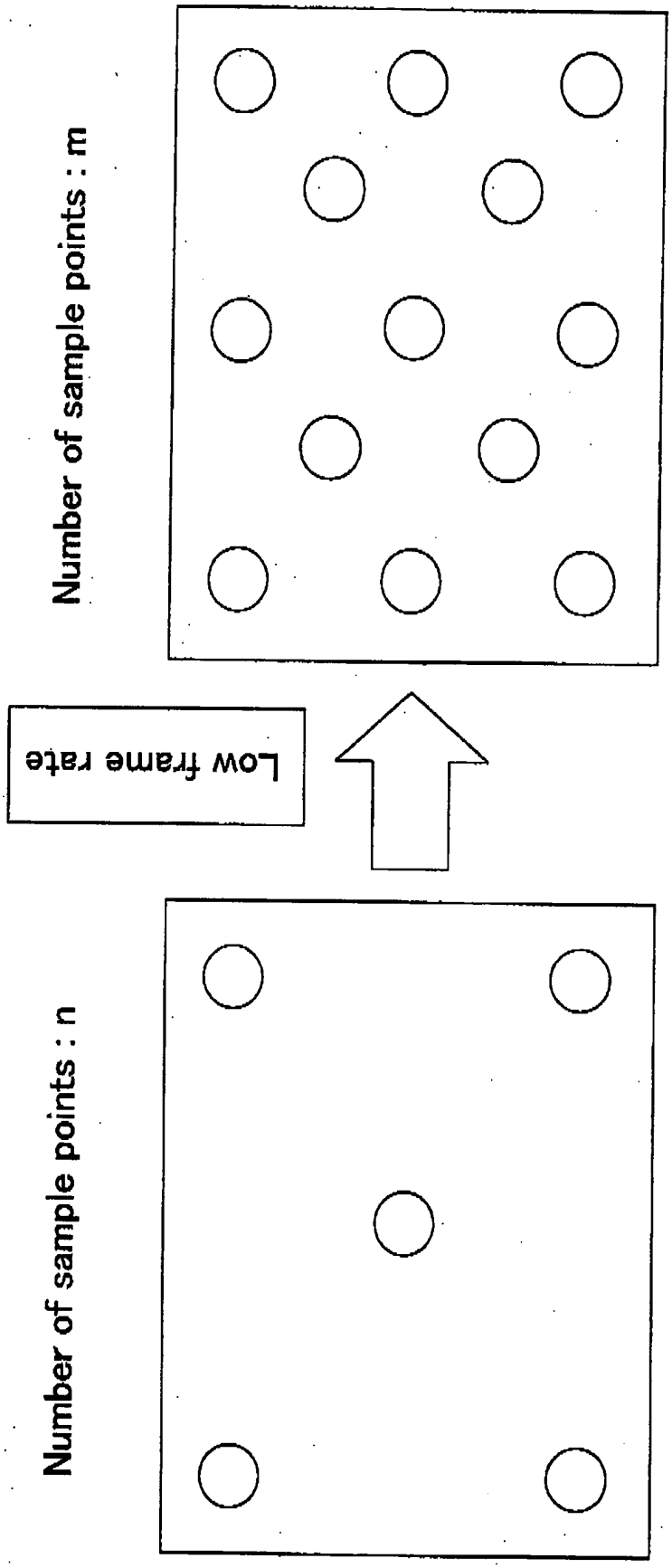

Number of sample points : m
Low frame rate
Number of sample points : n

FIG.24